BCHP Screening Tool Development

Integrated Energy System Peer Review Meeting

Jason Glazer
GARD Analytics
May 1, 2002

Design Engineer Question

"I have heard that desiccant systems, absorption chillers, and generators with heat recovery make sense in some buildings. They cost more than typical systems but they may save on operating costs. Will a system like this be cost effective in the building I'm now designing?"

How it was answered

- Engineering judgment
  - Requires previous experience with such systems
  - Spreadsheet and hand calculations
- Expertise of others
  - Could be expensive
- Building simulation software
  - Difficult to use - no appropriate user interface
- BCHP systems dismissed without further consideration

How it will be answered

- Direct use of the BCHP Screening Tool by the designer
- Use of the BCHP Screening Tool by a Regional CHP Application Centers
- Resulting in growing expertise in design community

Project Overview

- Screening tool
  - Comparing BCHP and conventional systems
  - DOE-2 building energy simulation engine
  - Comparative energy and economic results
- Develop databases for
  - HVAC equipment including thermally activated
  - On-site generating equipment
  - Utility rates
- Focus on U.S. commercial buildings
- Currently undergoing beta test

Target Audience
Not only design engineers

- CHP regional application centers
- Architecture and engineering firms
- Research and development engineers and managers
- Power generation, heating, ventilating and air conditioning equipment manufacturers
- Energy service companies
- Marketing personnel at utility companies

Project Structure

Six tasks allow for some parallel efforts

1. Model development, phase I*
2. Power generation equipment database*
3. HVAC equipment database*
4. Gas and electric utility rate structure database
5. Commercial building loads database*
6. Model development, phase II (integration)

* Complete except for additional testing and documentation

Approach

- Utilize DOE developed simulation engine DOE-2.1e
  - Hiding complexity with the user interface
  - Exposing flexibility of building, air distribution and plant
- User interface developed by GARD
  - Input flexibility
  - Minimizes development cost
  - Will be used with other screening tools
  - Compares multiple alternatives side-by-side
  - Tabular and graphical output
- Subcontract team of experts
  - Utility rates
  - Electric chiller data

Equipment Included

- Power generation: engine, turbine, microturbine and fuel cell
- Chillers: electric, absorption, and engine-driven
- DX Cooling and Heat Pump
- Cooling Towers
- Furnaces and Boilers
- Service water heating
- Thermal Storage

Task 1

Model Development Phase 1

- Loads/systems input file for 14 commercial building categories
- Flexible plant input file with heat recovery and use of data from equipment databases
- Enhance DOE-2
  - Better generators
  - Enhanced desiccants systems
  - Progress bar
- Test and benchmark enhanced DOE-2 with standardized tests

Task 2
Power Generation Equipment Database

- Data gathering
  - Much data available on internal combustion
  - Data more sparse for fuel cells, microturbines, turbines
- Curve fitting and database assembly
- Testing and Documentation
- 106 records with 50 fields, covering
  - Nominal performance
  - Off temperature and part load performance
  - First costs and maintenance costs

Task 3

HVAC Equipment Database

- Water cooled electric chiller data from Taylor Engineering subcontract
- Data gathering
  - Boiler, furnace, absorption chiller, engine chiller, DX cooling, heat pump, water heater, cooling tower
- Curve fitting, testing and documentation
- 7 tables with 440 records for specific models and generic equipment
  - Nominal performance
  - Off temperature and part load performance
  - First costs and maintenance costs

Task 4

Utility Rate Structure Database

- 160 Cities of gas and electric tariffs
  - National coverage
  - Climate diversity
  - Currently 100 complete
- Data base entry and quality assurance by two subcontracted experts in rate abstracting
- Flexible rate calculation program developed
- Utility rate editor under development

Task 5
Commercial Buildings Load Database Tasks

- Commercial buildings included:
  - Hospital, Large/Small Hotel, High/Low-Rise Office, School, Nursing Home, Supermarket, Full/Quick-Service Restaurant, Retail Store, Refrigerated Warehouse,Theatre, Ice-Skating Arena
- Speed of DOE-2.1e on modern PC's makes fixed load library unnecessary
- Greater flexibility with user changeable building parameters

Task 6

Model Development, Phase II

- Pulling all of the databases together
- Integrating the databases into the software
- Finalizing the software
- Testing the software
  - Internal tests
  - Beta tests

Summary of Major Accomplishments in 2001

- Completed the DOE-2 file and revised the DOE-2 program except for testing
- Completed the generator database of performance and cost details except for testing
- Completed the curve-fitting for the HVAC equipment performance
- Utility rates entered into the database for 100 cities
- Completed the loads database except for testing

In 2002

- BCHP Screening Tool version 1.0 will be released
  - All testing and finalizing of databases
  - Integration of databases into overall program structure
  - Development of utility rate editor
  - Beta testing and program revision
  - Final release of the software

Public/Private Partnerships

- Extensive interaction with the Midwest Regional Application Center and anticipated interaction with development contractors for Office of Power Technologies modular packaged systems
- Outreach provided through Midwest Regional Application Center and Office of Power Technologies Combined Heat and Power websites and publications in technical journals

Public/Private Partnerships (con't)

- Simulation engine - DOE-2.1e
  - USDOE, LBNL/University of California, Hirsch & Associates, Southern California Edison Co., Pacific Gas and Electric Co., Gas Research Institute, Electric Power Research Institute
- Annual climate database - TMY2
  - USDOE, NREL's Analytic Studies Division under the Resource Assessment Program
- Design climate database
  - Handbook of Fundamentals by the American Society of Heating, Refrigerating and Air-Conditioning Engineers

Questions?